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92-04363/

SCIENCE NEWS NOTE

Seasickness in Totally-Enclosed Motor-Propelled Survival Craft: Remedial Measures

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LANDOLT JP, MONACO C. *Seasickness in totally-enclosed motor-propelled survival craft: remedial measures.* Aviat. Space Environ. Med. 1992; 63:219–25.

Totally-enclosed motor-propelled survival craft (TEMPSC) are used to evacuate the crews of mobile offshore drilling units in emergencies. The small size and flat bottom of the TEMPSC predispose most occupants to seasickness, even in relatively calm waters. This paper discusses efforts required to improve the well-being of occupants in terms of reducing seasickness, dehydration, hypothermia, anxiety, and the other factors that contribute to loss of comfort and the will to survive. Specific recommendations include the provision of climatic control to regulate temperature, remove odors and provide fresh air; potable water, electrolytes, and survival rations; and an ample supply of motion sickness bags. Overcrowding should be avoided. Anti-motion-sickness drug therapy to control vomiting should be administered in two ways: initial injection of intramuscular scopolamine for fast action followed by a transdermal ear patch for long-term protection. Leadership and seasickness management should be requisite survival training for all oil rig workers.

A RECENT PAPER (12) reported on the incidence of seasickness in occupants of totally-enclosed motor-propelled survival craft (TEMPSC) who had successfully abandoned five mobile offshore drilling units (MODUs)—the Alexander L. Kielland, Ocean Ranger, Vinland, Ocean Odyssey, and Rowan Gorilla I. In four of these incidents, seasickness occurred in 75% or more of TEMPSC occupants. (It was not possible to establish whether or not TEMPSC occupants from the Ocean Ranger incident had been seasick because all evacuees perished at sea during rough weather conditions. However, the study of that disaster demonstrated the importance of employing sound techniques in launching TEMPSCs in winter storms if survival at sea is to be assured.) In the Ocean Odyssey incident, seasickness occurred in relatively calm waters of wave height 1 m; whereas, in the Rowan Gorilla I incident, it occured in severe seas of 15 m wave heights. In a study of seasickness among lifeboat occupants, Landolt and Monaco (13) reviewed several thousand peacetime marine incidents, reporting that only one lifeboat death could be associated, even remotely, with seasickness (TEMPSC occupant from the Vinland abandonment).

Even though conditions were harsh, the Rowan Gorilla I incident has shown that evacuees in an *intact* TEMPSC should not be rescued until weather and sea conditions improve. Not only did the TEMPSC withstand the punishment of a raging sea for more than 20 h, but its seasick occupants demonstrated the importance of adequate training and teamwork in survival. If there is severe damage to a TEMPSC, as in the case of the Ocean Ranger disaster, then rescue attempts should be made if weather and sea conditions allow it.

Rescue transfer from a TEMPSC at sea in Eastern Canadian coastal waters (where severeal MODUs are located) may not be practically possible for at least 36 h, and, in some cases, for days (5). This means that the real danger of seasickness is the fact that repeated vomiting in TEMPSC occupants could cause severe dehydration and loss of body electrolytes. If left unchecked, this would contribute, no doubt, to a serious loss in morale and the will to survive, along with a total loss of interest in everything, including participation in survival or rescue attempts.

In this paper, the causes of seasickness in TEMPSC occupants are explained, and advice is provided on how this problem and those related to other environmental stressors can be ameliorated.

Seasickness

Seasickness is the most common form of motion sickness. It is characterized primarily by the following signs and symptoms: pallor, cold sweating, nausea, and vom-

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This manuscript was received for review in April 1991 and revised in June and October 1991. The revised manuscript was accepted for publication in October 1991.

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iting. Associated with these signs and symptoms is a general feeling of malaise. Less reliable and consistent signs and symptoms have been reported in the literature, including drowsiness, yawning, headache, stomach awareness, social indifference, and mental confusion (14,15).

The onset and severity of motion sickness is dependent on several factors: the intensity, frequency, direction, and duration of the motion stimulus; the individual's susceptibility; the nature of the task performed; the head movements made by the individual; and the influence of other environmental factors such as odors (1,2).

Seasickness Conditions Specific to TEMPSC

TEMPSCs were not designed specifically with the prevention of seasickness in mind. A number of conditions in these craft are very potent inducers of motion sickness: small enclosure with poor visual reference, inappropriate seating arrangement, and lack of head and body support.

Small enclosure: TEMPSC occupants are confined in a small enclosed shell (see Table I). For example, the Whittaker 50/54 has three very small portholes; others, even fewer for occupant viewing of the exterior. A steering tower (wheelhouse) with several small windows allows the TEMPSC operator (coxswain) sufficient vision for maneuvering the lifeboat. Accordingly, occupants other than the coxswain, act as passive passengers, with their vestibular organs signalling varied and sometimes intense motion while their eyes signal no motion at all. This mismatch between the eyes and the vestibular apparatus was strikingly demonstrated in the case of the Rowan Gorilla I incident (13): whenever the coxswain had to turn on the lights at night to read his panel gauges, several TEMPSC occupants immediately became nauseated. Better shielding of gauge illumination would obviate this problem. Seven of the Rowan Gorilla survivors felt that the small size of the survival capsule contributed to their seasickness; four implicated the lack of windows as a factor.

Visual reference to the outside world could be provided in the design of future TEMPSCs by increasing the number of portholes, or by fabricating the domed top out of a safe transparent plastic material (nondistorting). In light seas, it is sufficient and safe to open the hatches to provide an outside view (for example, in the Ocean Odyssey incident). However, in rough seas, with wave heights up to 15 m or more, in which the TEMPSC disappears into the waves (such as in the case of the Rowan Gorilla I), it would then be advantageous to reduce the external visual field. The visual cues provided by the turbulent waves would not necessarily be congruent with the motion experienced by the body mechanoreceptors, and, accordingly, might even increase the sensory mismatch experienced by the TEMPSC occupants over that experienced with limited cues. Additionally, the fear and anxiety that could be caused by observing such a harsh outside world could lead to panic. In this regard, it might be prudent to employ a retractable screen in future TEMPSC designs, so that visual reference to really rough sea conditions could be eliminated.

Seating: Occupants sit upright in a variety of seating arrangements. In some Harding models, seating is arranged on longitudinal benches, with passengers facing each other, with their front or back directed outboard; that is, towards the TEMPSC's side. In the Whittaker survival capsule, the seating consists of two concentric rings of benches; in the 50/54-man capsule, passengers sit with their backs directed outboard; and in the Whittaker 34/38, the two rings of people face each other (see Fig. 1). Some older TEMPSCs have bench seats for passengers to sit facing forward; it would appear that this would normally be the seating arrangement of choice during motor-powered or sea-anchor-directed forward motion, if there were an associated good external visual reference. This is proven by the results of the Rowan Gorilla I incident, where three of the four coxswains did not get seasick (Fig. 1). Not only were they facing forward, but they also had good visual reference and were actively involved in steering the TEMPSC. (The remaining coxswain (#7) was very seasick wherever he sat.) Moreover, the three evacuees sitting directly across from the coxswain's position at the forward end of the craft were either only slightly unwell (#5) or did not get seasick. Even though their external vision was restricted, they, at least, were able to co-drive with the coxswain, and get the feel of the boat. Most of the other survivors were facing sideways in the 34/38-man Whittaker capsule; the majority were ill, *some dreadfully so.*

Excessive head and body movement: Much could be done to limit head and body movements in TEMPSCs

TABLE I. TYPICAL TEMPSC SPECIFICATIONS.

Make & model	Capacity	Dimensions			Total volume (m3)
		Overall length (m)	Overall width (m)	Overall height (m)	
Harding MCM 22	26	6.89	2.54	2.70	10.67
Harding Freefall FF34	40	10.52	2.95	3.55	26.89
Harding MCB 24	48	7.46	2.90	2.90	14.87
Harding MCM 60	60	8.61	3.16	3.20	21.32
Whittaker Survival Capsule	50/54	6.02	4.27	3.66	50.26*
Offshore Marine Engineering "Phoenix"	66	9.48	3.20	3.40	54.05*

* Estimated.

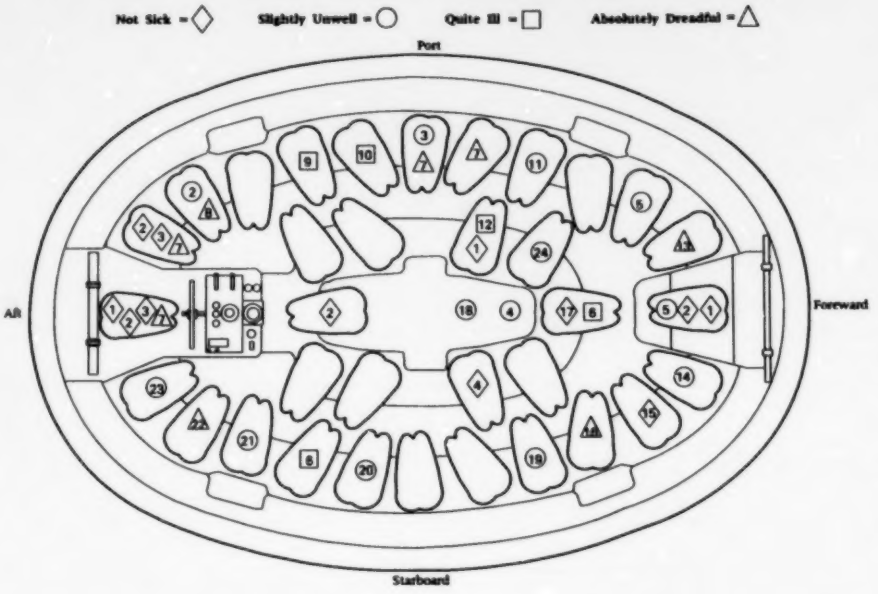

Fig. 1. Seating positions in the 34/38 Whittaker TEMPSC for 24 of 27 survivors from the Rowan Gorilla I incident. Some riggers, who occupied more than one position during their 22-hour ordeal, felt differently at different seat positions. For example, rigger #2 felt slightly unwell at one position, but was not sick at the others. In some locations, where more than one rigger shared the same seat, it likely means that one of them occupied an adjacent seat. Riggers #4 and #18 occupied non-designated seat positions.

so that the deleterious effects of the Coriolis reaction could be alleviated. Possibly, the worst condition for body restraint is to be found in those TEMPSC designs in which each occupant is secured to a bench seat by means of a simple lap belt without benefit of any back support. In some Harding models, each upright seat is provided with a four-point safety harness and a padded back and head support, which should reduce head and body motions substantially. In the 50/54 Whittaker capsule, personnel occupying the outer ring of seats can support their back and neck against the unpadded side wall of the TEMPSC. Those occupying the inner ring of seats must position their backs against the legs of the outer-ring occupants in order to get even limited back support. Head support is difficult to obtain for these occupants. All occupants in the Whittaker capsule are restrained by means of a lap belt.

The best back and head support is found in the Harding Freefall TEMPSC (13). Occupants are supported in partly-molded seats in recumbent positions with feet pointing either aft or forward depending on the model. Each seat is furnished with a shock absorbent polyurethane material to give comfort to the occupants and provide support to the sides and back of the body during transit. A lap belt, leg restraints and large headband secure the body and head to the seat. One improvement on this design would be to replace the headband with a good, padded head rest to restrict head movement. The headband could cause evacuees to choke on their own vomit if they were placed in a reclined position. Of the respondents from the Rowan Gorilla I incident, 63% reported that, given the choice, they would have preferred lying down to sitting upright in their TEMPSC.

Other Factors Contributing to, or Associated with Seasickness

Anxiety and odors: Conditions aboard a TEMPSC in eastern Canadian offshore waters are likely to be extremely uncomfortable for much of the year (5). Not only are occupants likely to become seasick from being tossed up and down continuously for many hours, but they must contend with extreme terror and anxiety for survival itself, as the TEMPSC is jerked about in the water, possibly even being inverted at times. Extensive craft vibration alone may be cause for alarm. The smell of vomit, feces, urine, diesel fumes, and other odors is extremely nauseogenic, and is made worse by the seating arrangements—occupants may be unable to direct their vomit except onto one another. Moreover, the small interior and the inability to see outside in such a vessel contribute to claustrophobia.

Because of the difficulty of ascribing the importance of the role of anxiety in motion sickness, the relationship between the two factors has been a contentious issue. Because of wide individual differences in susceptibility to motion sickness, it has been felt that personality differences may influence the way sensory information is processed. High levels of anxiety are known to decrease the capability of handling complex or demanding information processing. Therefore, anxiety may not only facilitate the induction of motion sickness, but may also hinder adaptation. A recent study has shown that the level of anxiety is significantly associated with subjects' reports of their own motion sickness symptoms (6).

Overcrowding and heat stress: By regulation, TEMPSC occupants normally wear closed-cell neoprene foam survival suits, and are strapped into their seats by lap belts or shoulder harnesses. The inability to move about is very tiring and stressful. Of survivors in the Rowan Gorilla I incident, 25% indicated that overcrowding is a problem if design seating capacity is to be met; they recommended limiting the number of occupants allowed in a TEMPSC. TEMPSC occupants from the Vinland rig found their survival suits to be so "bulky" that they were not able to fasten their safety belts (22). With each individual contributing about 100

watts of heat energy continuously inside the survival suit, heat stress is quite possible, particularly if oil rig abandonment occurs in the summer or during other warm air and water conditions. Profuse sweating inside the survival suit could seriously compound the dehydration associated with vomiting during seasickness. Of the Rowan Gorilla I survivors, 38% considered that excess heat within their TEMPSC contributed to their illnesses (13). As indicated elsewhere, the possibility of death due to rapid dehydration and loss of body electrolytes is a possibility if survivors must remain in a TEMPSC for several days.

Poor ventilation: The inherent poor ventilation of the TEMPSC itself will maintain a high internal temperature. Four persons from the Rowan Gorilla I incident cited poor ventilation and the smell of diesel fumes as problems. The foul smell inside the TEMPSCs from the Vinland incident eventually caused the occupants to open the hatches during transit. Poor ventilation may also cause a buildup of carbon dioxide, which could be life threatening to TEMPSC occupants who are forced by sea conditions to stay in the lifeboats for lengthy periods of time. Although the diesel engines used to drive the TEMPSC should burn fuel efficiently if properly maintained, the buildup of carbon monoxide cannot be ruled out entirely.

The Management of Vomiting in Seasickness in TEMPSC Occupants

The good management of vomiting in seasickness is paramount if dehydration and body electrolytic imbalance are to be minimized and controlled, and the effects of vomiting are to be kept from spreading to other survivors. The first step depends on the choice of an effective drug regimen that combines the following: easy administration and quick action with long-term prophylaxis.

Because of the small size of a TEMPSC (Table I) and the sea conditions envisaged, most occupants will become seasick, some vomiting within 15 min of entry into the water. Even with drug therapy, a good proportion of TEMPSC occupants will probably continue to suffer from seasickness and vomit for a short period of time. Thus, it is imperative that an adequate supply of fluids, electrolytes, and carbohydrates should be maintained in the TEMPSC as a second line of defense against the excessive loss of body fluids if potential survival times of 36 h or more are envisaged.

Drug therapy: Many drugs are available for controlling motion sickness (14,23). At least five are considered to be highly efficacious: scopolamine (called hyoscine in the United Kingdom), promethazine, cyclizine, cinnarizine, and dimenhydrinate. Amphetamine, used either alone or in combination with the others mentioned, is also effective; but its use is restricted because of its potential for abuse. Practical experience has shown that combinations of scopolamine and amphetamine are the most effective antimotion-sickness medications, with ephedrine and promethazine combinations being slightly less effective (15,23). Amphetamine combined with scopolamine is a particularly effective combination because the amphetamine overcomes some of the side effects of the latter. This combination has been the drug of choice of American astronauts in controlling space sickness (17). Cinnarizine has few side effects, and provides reasonably long-term protection; however, it is slow to achieve effective blood levels. A less effective drug, meclozine was used in the Vinland and Rowan Gorilla I incidents (12). Table II lists these different drugs, the recommended doses, approximate times of onset of drug effect, approximate duration of effect, typical side effects, and the conditions of motion for which they are most effective.

There are a number of routes by which antimotion-sickness drugs can be administered: by mouth (tablet or inhalation), sublingual (tablet or sachet under the tongue), buccal (sachet or tablet in mouth cavity), nasal (spray or drops), intramuscular injections, rectal (suppository), and transdermal (patch). The method of drug administration should be chosen not only on the basis of how rapidly it can elevate blood serum to therapeutic levels, but also on how fast it can cross the blood–brain barrier of the central nervous system (CNS), and be effective in suppressing symptoms of seasickness (7).

Drug administration routes—pros and cons: The by-

TABLE II. DRUGS RECOMMENDED FOR MOTION SICKNESS.[a,b]

Drug	Dose (mg)	Time of Onset (hours)	Duration of Effect (hours)	Side Effects	Severity of Motion
Amphetamine	5–10	1–2	8	Talkative, restlessness	Mild
Cinnarizine	30	2–5	6–8	Drowsiness	Mild to severe
Cyclizine	50	1–2	4–6	Slight drowsiness	Mild
Dimenhydrinate	50–100	1–2	6–8	Drowsiness, vertigo	Moderate
Meclozine	25–30	2	6–12	Drowsiness	Mild
Promethazine	25	1.5–2	24–30	Extensive drowsiness	Moderate/severe
Promethazine/ephedrine	25/25	1–2	12		Moderate/severe
Scopolamine (Hyoscine)	0.3–0.6	0.5–1	4–6	Dry mouth, drowsiness, blurred vision	Severe
Scopolamine patch (TTS)	1.5	6–8	72	Dry mouth, drowsiness, blurred vision	Moderate/severe
Scopolamine/amphetamine	0.3–0.6/5–10	1–2	6	Slight dry mouth	Severe

[a] Except for TTS patch, properties refer to oral routes of administration.
[b] Taken from References 2, 7, 16, 17, and 23.

mouth, sublingual and buccal methods have the advantage of speed and simplicity. However, in a TEMPSC, with vomiting likely to occur in most individuals in half an hour or less following rig abandonment, the oral route is impractical, since most, if not all, of the drug would be lost, resulting in unpredictable and probably sub-therapeutic blood levels. Although sublingual and buccal sachets or tablets can be removed by hand before vomiting under normal circumstances, this is hardly practical for TEMPSC occupants, whose hands are covered by an integrated survival suit.

Drug administration directly into the lungs by means of oral inhalation from an aerosol container has the potential for rapidly introducing the drug into the blood stream (12). Golding (7) expects a fast onset time for scopolamine aerosols or nasal sprays based on the analogy of the rapid absorption speed of other fast-acting drugs delivered by inhalation, such as nicotine. However, this method of delivery is not practical at the present.

Rectal suppositories are effective and easy to store. However, the average "rigger" may find the rectal method of administration both impractical and offensive, and would probably decide not to take anything. The drug would also have to be administered before donning the survival suit, which is not always possible, or, indeed, advisable in an emergency situation. Furthermore, once the survival suit has been zipped up and the TEMPSC occupants are restrained in their seats, any subsequent doses would be awkward and embarrassing, if not impossible, to give.

The intramuscular method can be very effective and quick acting. Pharmacokinetic studies show that scopolamine achieves a maximal blood serum level in 10 min following intramuscular injection (10,16). CNS induction times are not known (7); however, clinical effects appear to be delayed and long lasting in comparison to the rapid absorption and quick disappearance of the drug from the serum (11). Symptoms of seasickness were controlled in 86% of lifeboat occupants within 15 to 30 min of intramuscular scopolamine administration in experiments conducted by the Royal Navy (3). Benson (2) recommends intramuscular injections of scopolamine, cyclizine, or promethazine for controlling severe and repeated vomiting. Other studies show benefit within 10 min in severely motion sick subjects taking intramuscular injections of promethazine or scopolamine (8). Anecdotal evidence suggests that intramuscular promethazine effectively "cures" space sickness; however, little information has been given about side effects for this drug by that route.

The intramuscular method requires reliance on a second person to administer the drug, unless a self-injection technique is used. Self-injection methods are considered efficient, but may be less than satisfactory for administering the drug to TEMPSC occupants wearing bulky survival suits. It might be possible to adapt auto-injectors, which are used to protect soldiers from chemical agents, into self-injection devices for antimotion-sickness drug injections (9). The Polyinject syringe manufactured by Poutrait-Morin, France could be suitable for use with neoprene survival suits.

Nasal administration of antimotion-sickness drugs is one method which could overcome some of the problems encountered with other techniques. It is easily and (likely) willingly performed by the occupants themselves. The wearing of protective clothing should be no obstacle to drug delivery; nor should recurrent vomiting affect drug delivery to the blood stream. Two studies in the 1950's showed that scopolamine administered intranasally, either as a spray or in drops, provides protection against air sickness. Moreover, the speed of drug absorption was fast, occurring within 10 min (4,21). Further work to refine the technique and assess its potential in preventing vomiting in seasickness is required. Nothing is known about the duration of effect for different drugs following nasal administration.

The transdermal patch method entails drug delivery slowly through skin absorption directly into the blood stream. The drug avoids the powerful deactivation produced by the digestion processes and the direct first pass through the liver that occurs when taking tablets or suppositories. Normally, the patch is easily self-applied and delivers the drug over a prolonged period (18). However, in the conditions that might prevail just prior to rig evacuation, the neck may be oily and sweaty, and, therefore, render it impossible to apply the patch to the skin (7). Studies have shown that the transdermal patch employing scopolamine—the only drug available for this route of delivery—is effective in 75% of susceptible subjects, depending on the severity of motion (19).

Suggested drug regimen: Scopolamine is currently the most effective single drug for protecting against motion sickness (14,15), and there is a need to introduce it rapidly into the blood stream. A practical drug regimen for protecting against seasickness in TEMPSC occupants is recommended as follows: as soon as the need for rig abandonment has been established, the evacuees should take scopolamine by intramuscular injection for immediate prophylaxis. (The procedures for this implementation are beyond the scope of this paper; that is, whether by self-administration, administration by a mate at the rig abandonment station, administration by rig medic, etc.) Seasickness protection can be achieved by an intramuscular injection of a 0.2 mg dose of scopolamine, which should be effective for some 4 to 6 h (3,18). CNS side effects for such a dose were not found severe in liferaft trials conducted by the Royal Navy (3). The drug should be administered directly through the survival suit into the vastus lateralis (outside mid-thigh muscle). Injection through the survival suit would not cause any significant leakage during any subsequent immersion. Alternatively, the drug could be introduced into the deltoid muscle (the prominent muscle covering the upper part of the arm). If an abandonment suit is worn at the time of drug delivery, the upper part of the suit can be unzippered and the drug administered.

Immediately after the intramuscular administration of scopolamine, a transdermal scopolamine patch should be secured to the cleansed skin behind the ear for long term prophylaxis. The patches take effect 6–8 h after application, and, combined with the intramuscular injection, should assure that there will be continuous pharmacological protection against seasickness for up

to 72 h (see Table II). Should the duration of effectiveness of the intramuscular scopolamine injection be less than the 4 to 6 h quoted in Table II, then a second injection may be required.

Parrott (15) has written extensively on the possible side effects of transdermal scopolamine, while acknowledging its therapeutic properties. He emphasizes the fact that there may be differences between individuals both in the effectiveness of the drug and in the severity of the side effects. Thus, both intramuscular and transdermal scopolamine should be tested on each rigger during survival training in seasickness conditions in order to assess, for that individual, whether scopolamine is effective and if the side effects can be tolerated. If not, then intramuscular injections of promethazine or cyclizine should be tested on that individual as possible alternatives.

Other essential preventative steps: All oil riggers should experience rough sea conditions that will cause seasickness during survival training. The importance of such training in maintaining their confidence was cited by more than one-third of the survivors of the Rowan Gorilla I incident. In fact, the organization which conducted the training, Survival Systems International, insists upon having its trainees experience some seasickness, if possible, as part of the psychological conditioning process for overcoming their fear of the unknown sea (A. P. Bohemier, personal communication). Trainees are put into liferafts for an hour or more in sea conditions with waves up to 8 m high and winds up to 40 knots. Up to 90% of trainees experience seasickness under such extreme sea conditions; on the average, 60% become seasick under more moderate conditions.

The riggers need to know that it is highly likely that they will become seasick in spite of the drugs (especially if the stimulus is violent); that it is a natural response to which they can adapt; and having adapted, they should no longer be prone to seasickness for the duration of the ordeal provided that the sea state does not change dramatically. They also need to know that death from seasickness is extremely rare, and if in the very unlikely event that it does occur, it should only come as a result of several days of dehydration, which can be controlled if proper precautions are taken.

Conclusions

The circumstances that exacerbate seasickness in TEMPSCs are: 1) small confined space; 2) poor external visual reference; 3) occupants are passive passengers; 4) seating arrangements face in different directions; 5) poor head support; 6) having to sit upright; 7) smell and sight of another vomiting; and 8) light from coxswain's panel gauges when turned on at night.

Other factors that contribute to seasickness or loss of comfort in TEMPSC are: 1) anxiety about being tossed around; 2) odors such as smell of feces, urine and diesel fumes; 3) overcrowding; 4) individual heat stress resulting from wearing bulky survival suits; 5) poor ventilation; 6) no potable water; and 7) no antimotion-sickness medication.

Recommendations

Providing comfort to TEMPSC occupants—immediate solutions: Kits containing adequate antimotion-sickness supplies of injectable intramuscular scopolamine and transdermal scopolamine ear patches should be located at each oil rig muster station, at TEMPSC launching stations and at each seat within the TEMPSC. Motion sickness bags should be placed at each seat to reduce the incidence of evacuees vomiting on each other. Plastic bags of potable water and electrolytes, and small packets of flavoured carbohydrates in liquid form should be provided for stays up to 5 days in the TEMPSC.

The number of people on board each TEMPSC should be decreased by 30 to 40% to reduce overcrowding. Moreover, the innermost TEMPSC seats should be filled first with occupants who are more susceptible to motion sickness. Additionally, each TEMPSC seat should be retrofitted with a four-point safety harness and padded back and head support to protect individuals during capsizing, and to restrain head and body movement at other times. The coxswain's gauges should be retrofitted with better dial illumination so that TEMPSC lighting need not be turned on, since this aggravates the evacuees who feel nauseated.

TEMPSC occupant training: During survival training each rigger should be provided with the basic knowledge, technical skills and experience for overcoming the fear of the sea, and how to handle problems of seasickness with special emphasis placed on leadership and the will to survive.

To alleviate problems in seasickness, each rigger should be tested, under medical supervision, on his or her ability to tolerate scopolamine with and without ship motion. If scopolamine is not tolerated, then the process should be repeated with cyclizine and promethazine, and appropriate steps taken to ensure their availability to the requisite TEMPSC occupants. Moreover, each rigger should be trained in the hypodermic administration of intramuscular scopolamine, and the requirements for administration of antimotion-sickness medication as soon as the call for rig evacuation is made.

TEMPSC design changes: To guard against damage during rig abandonment, the crashworthiness of the TEMPSC could be improved by redesigning and fabricating the hull out of impact-resistant composite materials and the dome from impact-resistant transparent materials that provide a visual reference in good sea conditions. In order to shield against external visual cues in very bad sea conditions, a retractable screen would be required within the transparent TEMPSC dome.

There is a requirement for a totally integrated climatic control system to control heat in warm weather and cold in winter, and to provide fresh air to remove carbon dioxide, carbon monoxide, and bad odors.

Research challenges: There is a need for further research into a drug of choice, which is specific for rig-abandonment evacuees; optimizes efficacy, time of onset and duration of action; and has minimal side effects. Likewise, research is required to assess the effectiveness and practicality of using nasal techniques, aero-

sols, and self-injection devices over current methods of drug delivery. The possibility of providing whole body heating in individual survival suits merits attention. Finally, a program of studies should be conducted to make recommendations on how to reduce anxiety in TEMPSC occupants in a survival situation.

ACKNOWLEDGMENTS

We are grateful for pertinent information provided by the following: the survivors of Rowan Gorilla I and Mr. R. M. Hattie, Rowan Companies, Inc., Halifax; Dr. I. M. Light and Capt. M. G. Greenen, Robert Gordon's Institute of Technology Offshore Survival Centre, Aberdeen, UK; Dr. J. F. Golding, Institute of Naval Medicine, Gosport, UK; Mr. A. Bohemier, Survival Systems International, Dartmouth, Nova Scotia; P. Werenskiold, Norwegian Marine Technology Research Institute, Trondheim, Norway; A. Pasche, T. Sten. O. Ingstad, and T. Ulleberg of the Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology, Trondheim, Norway; Dr. O. I. Molvaer, Norwegian Underwater Technology Centre, Bergen, Norway; P. Brinchmann, Harding A/S, Rosendal, Norway; Mr. J. A. Kelly, and Mr. J. Gow, Mobile Oil Canada Ltd., Calgary, and Mr. R. Kimberlin, Mobile Oil UK, London, for authorizing a visit to their oil rig "Beryl Bravo," and to Messrs. F. Huet, P. Woodhouse, and D. Clarke, Beryl Bravo, Mobile North Sea Ltd., for discussions and tours of their facility; Mr. J. Van Duinen, Bow Valley, Calgary, for arranging for a visit to their oil rig "Bow Drill I," and Mr. K. Valentine, Halifax, Nova Scotia, for a tour of that facility; Mr. D. H. Robertson, Marine Technology Support Unit, Oxfordshire, and Mr. J. Austin, London, UK, both with the Department of Energy; Dr. L. A. Laitinen, Central Medical Hospital, Helsinki, Finland; Dr. J. Kanto, Turku University, Turku, Finland; Surgeon Commander B. J. W. Pingree, Royal Naval Sick Quarters, Helensburgh, UK; and Dr. W. H. Johnson, St Michael's Hospital, Toronto.

Critical reviews of this paper were provided by Dr. C. J. Brooks, Dr. K. E. Money and Dr. M. J. Ballantyne. Ms. June Parris, Mrs. Nancy Wisteard, and Mrs. Brenda Zajakovski provided the typing; Mr. V. Praestegaard and Mr. E. Rypan the art work; and Mr. R. P. S. Cardin the editing of the report. We are very grateful for all these efforts.

Dr. Shaun D. Gill, Canada Oil and Gas Lands Administration initiated and funded this project. DCIEM Research Paper #91-08.

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